

MATH-351

**Advanced numerical analysis**

Picasso Marco

Cursus	Sem.	Type
Computational science and Engineering	MA1, MA3	Opt.
Financial engineering	MA1, MA3	Opt.
Mathematics	BA5	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Written
Workload	150h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

The student will learn state-of-the-art algorithms for solving ordinary differential equations, nonlinear systems, and optimization problems. The analysis and implementation of these algorithms will be discussed in some detail.

**Content****Numerical Solution of Ordinary Differential Equations**

Explicit Runge-Kutta methods. Order 4 conditions. Step size control. Convergence.

**Numerical Optimization**

Newton, BFGS and conjugate gradient methods. Constrained optimization problems. Optimality (KKT) conditions. Quadratic programming. Optimal control.

**Keywords**

Explicit Runge-Kutta methods, Newton, BFGS and conjugate gradient methods, Constrained optimization problems, Optimality (KKT) conditions, Quadratic programming, Optimal control.

**Learning Prerequisites****Recommended courses**

Some background in numerical analysis and proficiency in programming - Matlab/Octave recommended

**Important concepts to start the course**

Numerical methods for approximation, differentiation and integration of functions. Basic knowledge of ordinary differential equations and their solutions. Basic knowledge of numerical techniques for solving systems of linear equations.

**Learning Outcomes**

By the end of the course, the student must be able to:

- Analyze methods
- Choose an appropriate method
- Prove basis properties of methods
- Derive new methods
- Conduct computational experiments
- Implement computational methods

**Teaching methods**

Lecture style with computational experiments in class to illustrate analysis.

### Expected student activities

Students are expected to attend lectures and participate actively in class and exercises. Exercises will include both theoretical work and implementation and test of a variety of methods.

### Assessment methods

Written examination.

Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

### Resources

#### Bibliography

Lecture notes will be provided by the instructor. Complimentary reading:

Hairer, E.; Norsett, S. P.; Wanner, G. Solving ordinary differential equations. I. Springer, 1987.

Nocedal, J.; Wright, S. J. Numerical optimization. Second edition. Springer, 2006

#### Ressources en bibliothèque

- [Numerical optimization / Nocedal](#)
- [Solving ordinary differential equations / Hairer](#)